Even though many countries have realised the potential of broadband for economic, social and digital growth, there is still a huge proportion of the population, particularly in developing economies, that is yet to connect to the internet. Various industry reports suggest that by end-2016, more than half of the world's population (around 3.9 billion people) would still not be using broadband services.

This highlights the scale of the challenge in providing ubiquitous broadband connectivity and bringing everyone under the digital umbrella, especially in countries like India where a huge population resides in rural areas. These areas have limited physical infrastructure due to difficult terrain and the high cost of service provisioning, resulting in low broadband penetration.

At present, broadband connectivity in India is provided predominantly through digital subscriber line (DSL) or asymmetric DSL services, which require the deployment of expensive optical fibre cables. The other options for broadband services include cellular services (such as 2G, 3G and 4G) or unlicensed Wi-Fi-based solutions. While the former entails high licence fees and infrastructure deployment costs, unlicensed Wi-Fi solutions suffer from poor physical layer propagation characteristics, resulting in low coverage for every base station. The ensuing infrastructure cost is significantly higher in rural and remote regions.

A look at some of the emerging technologies that have the potential of providing reliable and affordable internet connectivity in the country…

Project Loon: Balloon-based connectivity

Project Loon is an initiative of X, the research division of Google's parent company Alphabet. The project aims to provide internet connectivity to remote areas through a network of balloons that float 20 km above the earth's surface in the stratosphere. Wireless internet signals are transmitted up to the nearest balloon from a telecommunications partner (ground-based station), relayed across the balloon network and then sent back down to users on the ground. Each balloon has a coverage area of 5,000 square km. The project uses predictive models and decision-making algorithms to determine the path taken by the balloons and to arrange them to provide coverage wherever needed.

Since its pilot test in New Zealand in June 2013, Project Loon has completed over 17 million km of test flights so far. It has demonstrated data transmission between balloons that are over 100 km apart in the stratosphere and back down to the ground with connection speeds of up to 10 Mbps.

In June 2015, Sri Lanka became the first country to sign an MoU with Google to implement Project Loon, with the aim of achieving 100 per cent broadband penetration in the country. The project began its first tests in February 2016 and was allocated the required spectrum in August 2016.

The Indian government too is keen on leveraging the technology to provide affordable broadband services. Initially, the proposal to test the project in the country was opposed by various ministries, including telecom, civil aviation, home and defence, owing to concerns related to spectrum, airspace, security and surveillance. However, the government has now decided to allow Google to conduct a pilot test of Project Loon in India. The location is expected to be in Andhra Pradesh or Maharashtra. The National Informatics Centre has been tasked with identifying the location and other requirements for the project. Meanwhile, state-run telecom operator Bharat Sanchar Nigam Limited (BSNL) has reportedly offered Google spectrum in the 2500 MHz band for testing the project. Google had earlier sought 5 MHz of spectrum in the 700 MHz band, which had been opposed by operators.

Aquila: Solar-powered internet drone

As part of its Internet.org initiative, Facebook has designed an unmanned solar-powered drone named Aquila, which beams internet connectivity to a base station on the ground. Aquila carries a communications payload that uses laser to transfer data more than ten times faster than the existing systems. The internet drone can circle a region for up to 90 days at an altitude of 90,000 feet during the day and 60,000 feet at night. Aquila is deployed using a helium balloon, which floats the drone up to around 70,000 feet, after which the drone detaches itself. Going forward, Facebook aims to have a fleet of such drones floating together at an altitude of 60,000 feet, communicating with each other through laser and staying in the air for months at a time.

Aquila’s first successful flight was completed in June 2016 in Yuma, Arizona. The drone was kept in the air for 96 minutes, as opposed to the initial target of 30 minutes. However, it reportedly suffered a structural failure that caused serious damage to it shortly before landing. The incident is under investigation.

Although there was talk of Facebook collaborating with the Indian government and telecom companies for potential programmes to bring Aquila to India, the social media firm has not confirmed these claims. Meanwhile, Facebook is reportedly in talks with internet service providers (ISPs) to commercially launch its Express Wi-Fi programme in the country, having completed a pilot roll-out of 125 rural public Wi-Fi hotspots in collaboration with BSNL. The

programme allows customers to purchase fast, reliable and affordable data packages from their local ISP to access the internet through local hotspots. Facebook has left it to its partners to come up with a scalable business model. The company, on its part, has developed customised software for rural markets, which will help ISPs and entrepreneurs to run a business within their localities, helping bridge coverage gaps in the country's rural cellular data networks.

LEO satellites

High speed bidirectional internet connection can be established through communication satellites located in the geostationary orbit. This requires low investment in passive infrastructure as a regional backbone and area networks are not needed. Moreover, it helps in connecting users who are scattered over a relatively large area.

Efforts are now being made to use low earth orbit (LEO) (which ranges from about 160 km to 2,000 km above the earth) satellites for providing broadband as these allow better connectivity, cover wider areas and are more affordable. To this end, US-based aerospace manufacturer Space Exploration Technologies Corporation (SpaceX) has announced its plans to develop a constellation of small, low-cost and disposable LEO satellites to provide global internet communication. The company has sought permission from the US Federal Communications Commission for launching 4,425 satellites into the earth's orbit. This will add redundancy into the satellite network, which would minimise the impact of the failure of one satellite on the overall communication system. The first version of the project is expected to be operational in the next five years and successive versions will follow. It would take 12-15 years for the system to achieve its full capability. Meanwhile, in January 2015, SpaceX received an investment of $1 billion from Google and Fidelity for the project.

A similar initiative, OneWeb (formerly known as WorldVu), has been launched by WorldVu Satellites Limited, which is supported by a global consortium of companies comprising Airbus, Qualcomm, the Virgin Group and Coca-Cola. Bharti Enterprises has recently acquired a strategic minority stake in OneWeb and will have a representation on the board of the company. By 2019, OneWeb aims to build a communications network with an initial constellation of 648 LEO satellites, which will provide connectivity to billions of people around the world. The OneWeb user terminals contain embedded long term evolution (LTE), 3G, 2G and Wi-Fi access capabilities that extend the network coverage of mobile operators. The system will have more than 10 Tbps of new capacity.

Television white space

Television white space (TVWS) refers to the unused portion of spectrum in television bands, such as guard bands between broadcasting channels and channels freed up by the transition

from analog to digital TV broadcasting. TVWS signals have a longer range, better speeds and robust non-line-of-sight performance as compared to other mediums. This coupled with abundant bandwidth allow TVWS to be used for delivering broadband in areas that are not easily accessible by cable at much lower costs than optical fibre or conventional wireless networks. In addition, TVWS can be used for machine-to-machine communication and to provide low-cost Wi-Fi services on university campuses and in public spaces. The world's first commercial TVWS network has been deployed in the US.

The key concern while deploying TVWS networks is protecting the interests of incumbent users of the TV band. To this end, Google launched a trial TVWS programme in South Africa, which showed that broadband could be offered over white spaces without interfering with the licensed spectrum holders. Similar trials were undertaken in the UK as well.

Meanwhile, in the Indian context, multiple studies have shown that there is a large quantum of unused TV spectrum in the 470-590 MHz band. Moreover, the impending shift from analog to digital systems is expected to free up even more spectrum. This unutilised spectrum can thus be used to increase broadband penetration in the country.

However, the Department of Telecommunications (DoT) has decided not to allocate the 470-590 MHz band for the commercial deployment of TVWS technology. According to DoT, this band will not be delicensed and the government will put it up for auction in the future when the ecosystem for this band is developed. At present, the white space spectrum band has been assigned to various educational and research-based organisations with the sole purpose of carrying out experiments in TVWS technology.

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